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Quantitative civic literacy

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Mathematizing the World

In the mathematics content breakout session of a teacher education course I teach at Saint Mary's College of California, Humanizing Education Methods, we devote a segment of each class to learning about how mathematics teachers and students "mathematize the world." We draw on texts such as *Rethinking Mathematics* (Gutstein & Peterson, 2013) and *Math that Matters 2* (Stocker, 2017), blogs such as Frances Harper's *Solving World Problems* (2018), and websites such as as RadicalMath. As a mathematics education professor and researcher and former urban high school mathematics teacher, I engage in this work as part of a larger aim to prepare future mathematics teachers to teach for a more socially just world.

One evening, in a lively discussion on how students may learn about the difference between mean and median as they explore data on U.S. family income and wealth over time, one of my teacher education students wondered aloud: How can we not only study societal inequality in math class but also support students to *do something* about it?

Civics education is often positioned as the social science teacher's job.[1] However, if we view mathematics as a discipline that is essential to understanding, revealing, and informing action on pressing issues of societal inequality, then it is also the job of the math teacher. As we do the work of reimagining mathematics classrooms as interdisciplinary, problem-posing spaces that connect to students' lives, communities, and the world, how can we help prepare young people to develop as civic actors, using their mathematical knowledge and skills to build their *quantitative civic literacy?*

In response to the student's query, I turned my teacher candidates' attention to the *teaching for social justice* (also referred to as *critical mathematics*) scholarship and practice-based pieces we had read. Indeed, these texts put forth a goal that teaching mathematics should be to support young people to be critical and active participants in their democracy. In *Rethinking Mathematics*, Gutstein and Peterson (2013) explain, "As students develop deeper understandings of social and ecological problems that we face, they also often recognize the importance of acting on their beliefs. This notion of nurturing what Henry Giroux has called 'civic courage'—acting as if we live in a democracy—should be part of all educational settings, including the mathematics classroom" (p. 4).

Gutstein (2006) refers to students taking action as "writing the world with mathematics," borrowing from Freire's (1970) notion of "reading and writing the world." He emphasizes that students coming to write the world with mathematics is a gradual process that occurs over time. No single mathematics lesson can offer the range of ways that people may take action on issues of inequality. However, teachers can build students' sense of agency, supporting them to see ways they are "capable of contributing to historic processes" in collective endeavors (p. 27), which they can apply in the future and in contexts outside of the mathematics classroom. So that students can understand how mathematics can be an "instrument

1 While most states require civics coursework, participatory elements and community engagement are not common.

of social change" (Brelias, 2015, p. 10), what are some examples of how mathematics teachers integrate action in their mathematics lessons about societal inequality?

Taking Action in Mathematics Class

In a germinal piece, Tate (1995) examines a case study of a mathematics teacher of African-American middle school students, noting that the teacher's overarching goal is to "develop students into active participants in the democracy" (p. 170). The teacher seeks to connect social issues to mathematics, asking students to explore the ratios of different community resources to people, and then compare those ratios to ones in neighboring communities. Drawing on their mathematics work with proportions, the students ultimately present data to their city council to challenge the disproportionate number of liquor stores in their neighborhood.

In a more recent case study, Gregson (2013) describes how a mathematics teacher drew on her own background as an activist to design a unit on the discrepancy between workers' wages and a fair wage. She supported students as they wrote letters to a fast food chain reporting their findings and also accompanied them to a rally related to workers' rights. Gregson argues that these actions offered students "a powerful example of how collective organizing can improve social conditions" (p. 25).

Youth Participatory Action Research (YPAR)—a process in which youth identify an area of inquiry, design and conduct a research study, and then take action—is another domain where students can take action related to mathematical or statistical learnings. Some examples include Terry (2011), who describes Black male youth in South Los Angeles engaging in mathematical counter-storytelling to challenge dominant narratives. Yang (2009) describes students creating their own school report cards with quantitative ranks to measure areas important to the students, such as culturally relevant teaching. I have written up the results of a YPAR project in which my Algebra students conducted a school-wide survey on school food injustice, presented their results to the cafeteria manager, and invited the community's Healthy School Food Coalition to be partners in their work (Raygoza, 2016a).

Rethinking Mathematics (Gutstein & Peterson, 2013) also presents examples of student action informed by mathematics, including students who spoke out in public forums after doing a mathematical analysis of overcrowding at their school, and students who wrote letters to a social studies textbook publisher after doing a mathematical analysis of slaveholding presidents and noticing the textbook did not address this part of history.

What Kind of Mathematics Student?

While these examples help us to imagine civic action with mathematics, it is important to keep in mind that there is not a singular way of conceiving what it means to develop students as civic actors. Just like teachers come into the profession with a wide range of ideological views on the purpose of schooling, they have various ideas about what it means to be a "good citizen." Especially if not centered in teacher education and professional development, mathematics teachers may not have had opportunities to develop clarity in their vision of the kind of "good citizen" their mathematics students could become.

For guidance on thinking through this further, I turn to Westheimer and Kahne's (2004) "What Kind of Citizen?" article on the different ways social studies teachers conceptualize young people as citizens of a democracy. They argue that there are different visions of developing students as civic actors, and such visions are political in that they include particular perspectives on societal inequality and how people could improve society. In other words, the curricular and pedagogical decisions made by teachers advance a vision of the kinds of democratic citizens young people could become. Specifically, Westheimer and Kahne identify three over-arching conceptualizations of citizenship based on theoretical perspectives and their empirical research on civics education programs: the *personally responsible citizen*, the *participatory citizen*, and the *social justice-oriented citizen*. I will discuss each of these conceptualizations and apply them to different ways students could engage in civically minded mathematics.

The *personally responsible citizen* engages in charitable acts, such as donating to a food drive or giving blood, or participates in community service such as picking up trash. A mathematics teacher could engage students in looking at data reflecting structural inequality and give examples of or create space for personally responsible acts as responses to such inequality. In a study of elementary and secondary social studies teacher education students' perspectives on citizenship, Martin (2008) found that teachers tend to emphasize community service over political engagement. Do mathematics teachers also emphasize community service over political engagement as they engage their students in study of social problems?

Another example that Westheimer and Kahne provide for the *personally responsible citizen* is a focus on financial literacy, which mathematics teachers may take up, because particular mathematics concepts are key to financial literacy (e.g., the role of compound interest in loans and in saving). Baron's (2015) Count on Yourself program, designed to teach students and parents the mathematics behind financial literacy, operates from the perspective that if students and their parents have greater mathematical abilities, they will be more financially prosperous *and* more informed citizens.

While developing a *personally responsible citizen* is essential, Westheimer and Kahne argue that a combination of characteristics of the *participatory citizen* and *social justice-oriented citizen* are required to prepare young people to participate in a democracy, because these conceptualizations assume a greater focus on collective action than individual action. For example, to participate in a democracy, people must go beyond following the laws as "responsible" individuals, to knowing how laws are developed, voting on them, and organizing to change them. *Participatory citizens* "actively participate in the civic affairs and the social life of the community at the local, state, or national level" (p. 241). They participate and take leadership in government or community organizations in order to advance change as a collective. In the mathematics classroom, this form of participation might look like students using mathematics as a tool to inform voters on policies relevant to inequality or as a tool in "participatory budgeting," a process through which citizens exert control over governmental budgets (Pateman, 2012).

The *social justice-oriented citizen* believes that "citizens must question, debate, and change established systems and structures that reproduce patterns of injustice over time" (Westheimer & Kahne, 2004, p. 240). This view of citizenship is perhaps most consistent with the ideology underlying *teaching mathematics for social justice* (Aguirre & del Rosario Zavala, 2013; Bartell, 2013; González, 2009; Gutstein, 2006; Tate,

1995; Wager & Stinson, 2012). This involves acting to change social, political, and economic structures.

Whereas *a personally responsible citizen* would donate to a food drive and a *participatory citizen* would organize it, the *social justice-oriented citizen* would identify and challenge the root causes of hunger. Key to preparing a social justice-oriented citizen is exploring the role of social movement and grassroots organizing to challenge systemic injustice. In the mathematics classroom, students might explore how mathematics is a tool for grassroots organizing on racial and economic injustice, such as within the Black Lives Matter movement or the Occupy movement.

Mathematics teachers can explore ways to develop their students as civically engaged mathematics students by bringing these conceptions of different kinds of citizens to the mathematics classroom and asking them, "What kind of mathematics student would you like to be?" Just as in social science classrooms, in the mathematics classroom we can equip students to understand civic action through a personally responsible, participatory, and/or social justice lens. In professional development with teachers, Bartell (2013) found it was common for mathematics teachers to "recognize that action is a critical component of teaching mathematics for social justice" but "not take a stand on whether or not that action is about students transforming their world" (p. 13). How can we as mathematics educators articulate and sustain our visions for supporting students to transform the world with mathematics?

Developing a Pedagogy for Quantitative Civic Literacy

I hope to continue to work with my teacher candidates to think about what forms of quantitative civic literacy we hope to help students cultivate. In future work, I am committed to taking up the following, and would like to call on other mathematics educators to join me in dialogue around these areas:

- Extend frameworks for what it means to develop quantitative civic literacy.
- Develop an eye for finding examples of people using mathematics as a tool for social change (recognizing that social and political consciousness are always evolving), and support the continuous development of that eye in one another.
- Seek to observe (in-person or via video examples) classroom activities designed to enhance quantitative civic literacy, focusing on how teachers build classroom community, center students' lives in the exploration, pose questions, facilitate dialogue, and support students to engage in action.
- Learn how other teachers have advocated for the curricular time and space to teach and develop quantitative civic literacy, considering that the pressures and constraints of high-stakes testing often prevent teachers from doing this kind of work (Raygoza, 2016b).
- Identify and contribute to venues in a school beyond the mathematics classroom where students can develop quantitative civic literacy (e.g., as part of interdisciplinary project-based learning units that span classes, in leadership or advisory classes, or in youth participatory action projects in after-school spaces).

- Arrange guest speakers and field trips that enhance students' quantitative civic literacy.
- Attend conferences such as Creating Balance in an Unjust World Conference on Mathematics and Social Justice and TODOS Mathematics for ALL to learn about ways in which young people specifically have engaged in a range of actions informed by or with mathematics—globally, nationally, and locally.
- Discover how students feel critical mathematical exploration influenced them years beyond their time in the class (e.g., see Buenrostro, 2016, who interviewed students years after taking a social justice mathematics class), and use those understandings to inform future work on teaching quantitative civic literacy.

If mathematics educators collectively engage in these practices and share their wisdom and experiences, we can deepen our understandings of how to teach quantitative civic literacy.

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